



Uniaxial Compression of TNT and Comp-B at Strain Rates of 0.1, 1.0, 10.0, and 100.0 s⁻¹

by Michael G. Leodore and Frederick B. Pierce

ARL-TR-2359

October 2000

Approved for public release; distribution is unlimited.

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Citation of manufacturer's or trade names does not constitute an official endorsement or approval of the use thereof.

Destroy this report when it is no longer needed. Do not return it to the originator.

Abstract

Two lots of TNT and Comp-B explosives were tested in uniaxial compression at strain rates of 0.1, 1.0, 10.0, and 100.0 s⁻¹. The materials were tested at 21 °C to an end strain of 80%. The stress at failure, strain at failure, compressive modulus, failure modulus, incremental energy density, and the fracture assessment values were recorded for each test.

Table of Contents

	<u>Page</u>
List of Figures	v
List of Tables	v
1. Introduction	1
2. Approach and Results	1
3. Conclusions	1
4. References	9
Appendix: Quasi-Similar Materials Tested in Uniaxial Compression at 21 °C Using Strain Rates of 100.0 s ⁻¹	11
Distribution List	15
Report Documentation Page.....	35

INTENTIONALLY LEFT BLANK.

List of Figures

<u>Figure</u>	<u>Page</u>
1. Material Testing System for Energetic Materials	2
2. Energetic Material Being Loaded for Testing.....	3
3. TNT and Comp-B Stress vs. Strain Plot	5
4. Photograph of Tested Comp-B Materials	6
5. Photograph of Tested TNT Materials	7

List of Tables

<u>Table</u>	<u>Page</u>
1. MTS SHT Mechanical Properties Test.....	4
A-1. Mechanical Response of Detasheet and AX Classic HE at Strain Rates of 100.0 s^{-1}	13
A-2 Mechanical Response of JA2 Gun Propellant at Strain Rates of 100.0 s^{-1}	13

INTENTIONALLY LEFT BLANK.

1. Introduction

The U.S. Army Research Laboratory (ARL), Aberdeen Proving Ground, MD, received two lots of trinitrotoluene (TNT) and Composition-B (Comp-B) high-explosive molded pellets that had been cast into right-circular cylinders. Both lots had diameters of 9.80 mm. The explosives were shipped to Dr. Robert Lieb at ARL and were last tested for mechanical response evaluation during April/May 1999. It was decided by Dr. Pat Baker, also of ARL, that uniaxial compressive testing at strain rates of 0.1, 1.0, 10.0, and 100.0 s⁻¹, while conditioned at 21 °C and ambient pressure, would be performed on the materials to 80% end strain.

2. Approach and Results

The TNT and Comp-B high-explosive lots were received as right-circular cylinders or pellets that had been cast by the Explosives Modeling Facility on Spesutie Island at ARL. The cast materials were cut into test specimens using a double-bladed low-speed Isomet diamond saw that resulted in test specimens with a length-to-diameter ratio of 1.61 and a mass of 1.780 grams.

The Material Testing Systems (MTS) Servo-Hydraulic Tester (SHT) (Figures 1 and 2) was used to conduct MTS SHT mechanical properties tests [1-9] on five specimens per lot, per strain rate (40 tests) at 21 °C. Strain rates of 0.1, 1.0, 10.0, and 100.0 s⁻¹ were achieved. The specimens were taken to 80% end strain while at ambient pressure. The stress at failure, the strain at failure, the modulus, the failure modulus, the incremental energy density, and the fracture assessment values were recorded for each test. The average engineered values recorded and the standard deviations are listed in Table 1.

3. Conclusions

Two lots of TNT and Comp-B high-explosive molded pellets were received at ARL. The lots were cut into right-circular cylinder test specimens with a length-to-diameter ratio of 1.61

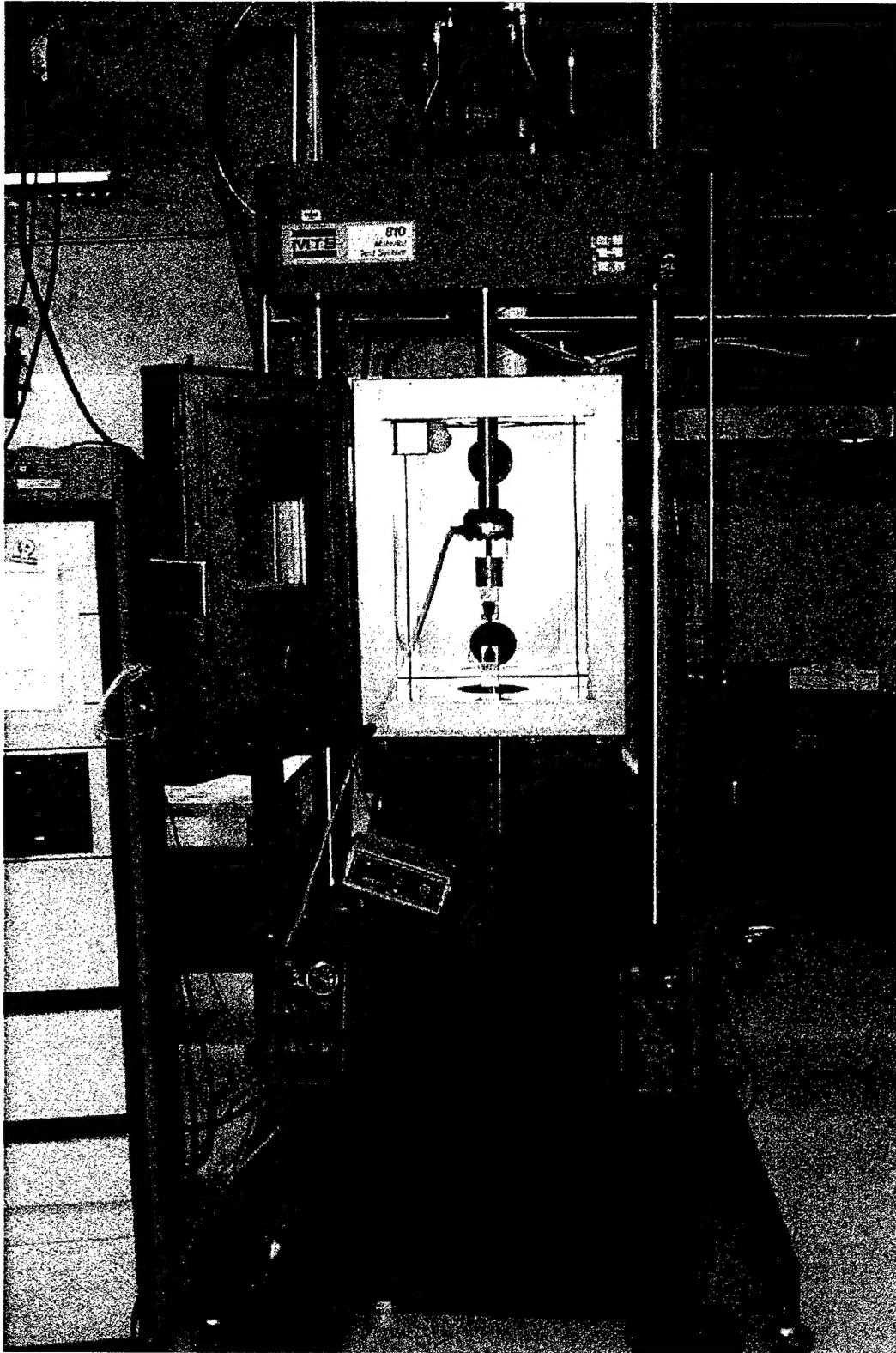


Figure 1. Material Testing System for Energetic Materials.

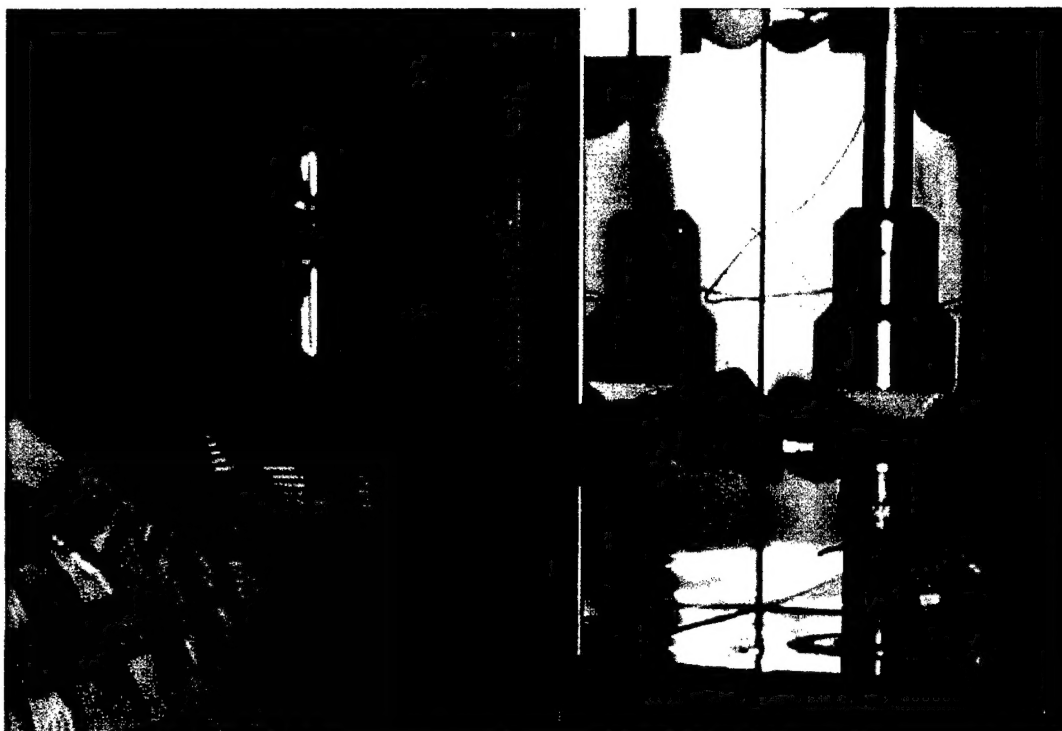


Figure 2. Energetic Material Being Loaded for Testing.

and a mass of 1.780 g. The specimens were tested in uniaxial compression to 80% end strain using strain rates of 0.1, 1.0, 10.0, and 100.0 s^{-1} (Figure 3) while conditioned at 21 °C.

The TNT and Comp-B specimens tested at 0.1 s^{-1} strain rate showed poor mechanical integrity, only achieving ~3.0 MPa stress at failure and ~2.0% strain before fracturing/collapsing into smaller shards and powdered remains (Figures 4 and 5). A visual observation of the tested remains suggested the TNT and Comp-B materials likely lacked binder constituents which would improve the mechanical strength and cohesion of the specimens. The TNT stress at failure and modulus values were slightly higher than the Comp-B values, possibly due to the differences in the formulation of the TNT and Comp-B lots.

At 1.0 s^{-1} strain rate, the TNT and Comp-B stress at failure values showed a small increase when comparing the stress values achieved at 0.1 s^{-1} strain rate. The compressive modulus and failure modulus values also showed higher values. The increased values achieved were a result of the higher strain rate and indicated the TNT and Comp-B lots showed strain rate sensitivity.

Table 1. MTS SHT Mechanical Properties Test

Lot Number	Stress at Failure (MPa) (±)	Strain at Failure (%) (±)	Modulus (GPa) (±)	FMOD ^a (GPa) (±)	IED ^b (MPa) (±)	FAV ^c
at 21 °C						
0.1 s ⁻¹ TNT ABY99CO31S009	3.98 0.67	1.94 0.35	0.304 0.06	-0.216 0.04	0.109 0.04	7AS ^d
0.1 s ⁻¹ Comp-B ABY99CO31S010	2.74 0.58	2.38 0.65	0.214 0.05	-0.163 0.01	0.179 0.04	7AS
1.0 s ⁻¹ TNT ABY99CO31S009	4.46 0.33	3.05 0.56	0.319 0.03	-0.228 0.03	0.186 0.04	7AS
1.0 s ⁻¹ Comp-B ABY99CO31S010	4.61 0.79	2.28 0.30	0.232 0.03	-0.207 0.02	0.248 0.03	7AS
10.0 s ⁻¹ TNT ABY99CO31S009	4.16 1.40	2.82 0.77	0.281 0.06	-0.186 0.04	0.268 0.03	7AS
10.0 s ⁻¹ Comp-B ABY99CO31S010	5.47 0.53	2.27 0.85	0.272 0.05	-0.337 0.10	0.364 0.11	7AS
100.0 s ⁻¹ TNT ABY99CO31S009	7.81 1.60	3.49 1.01	0.448 0.19	-0.373 0.11	0.457 0.09	7AS
100.0 s ⁻¹ Comp-B ABY99CO31S010	5.54 1.25	2.12 0.85	0.372 0.08	-0.252 0.09	0.448 0.04	7AS

^a The slope of the curve after yield. Generally, a negative value indicates the material is unable to sustain load. A positive value indicates a positive failure slope (i.e., material is better able to support load).

^b The IED (incremental energy density) value reported is the amount of energy absorbed at 25% strain. This includes a portion of the area located under the stress/strain curve (Figure 3).

^c The tested specimens were assigned a fracture assessment value (FAV). The values assigned range from 0 (no fracture/splitting/barreling) through 9 (severe fracture/splitting/barreling).

^d The mode of failure was also characterized using the following:

A = axial fracture, S = shear fracture, B = barreling, R = radial splitting (i.e., 7AS would indicate the tested specimens suffered moderate to severe amounts of axial and shear fracture damage).

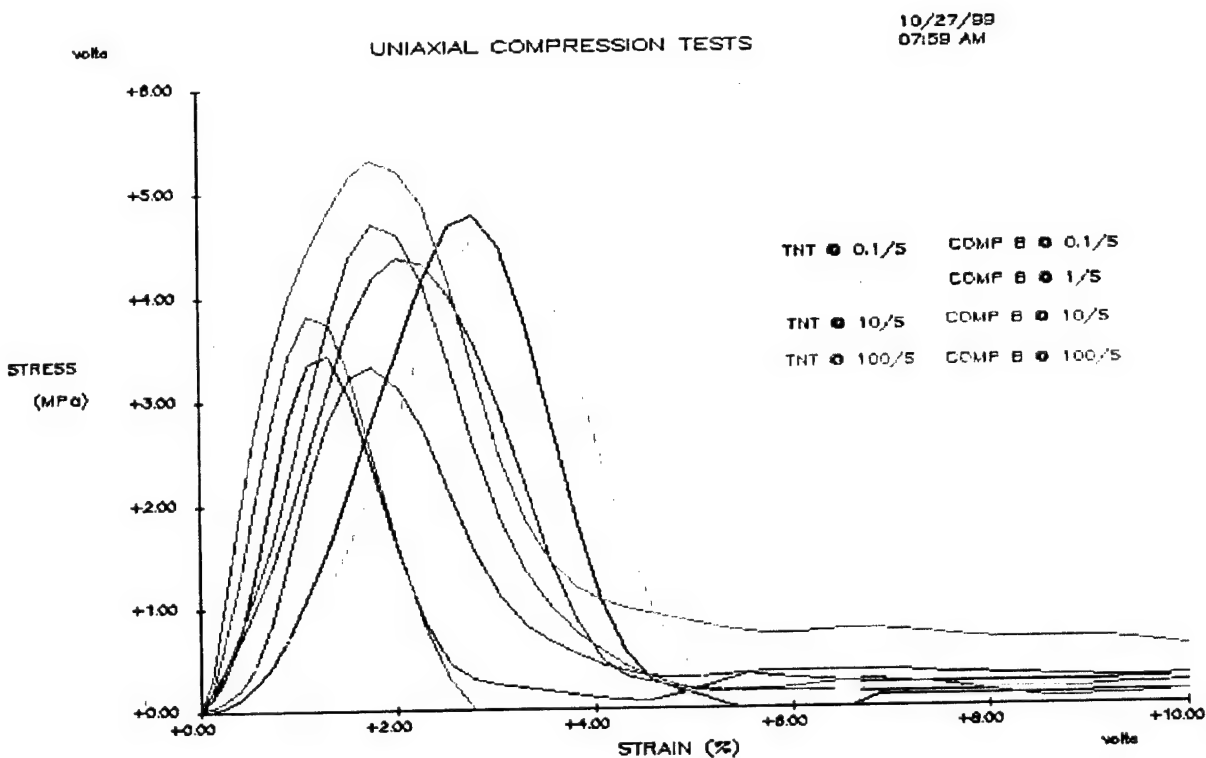


Figure 3. TNT and Comp-B Stress vs. Strain Plot.

The tested specimens yielded similar fracture damage, shards, and powdered remains, as was observed at 0.1 s^{-1} strain rate.

At 10.0 s^{-1} strain rate, the TNT stress and modulus showed a slight decrease when comparing the 10.0 s^{-1} with the 0.1 and 1.0 s^{-1} strain rate values. This was atypical as slight increases were expected. Specimen irregularities and void content could account for the unexpected decrease in stress and modulus results. The standard deviation numbers were slightly higher than usual for the TNT lot at 10.0 s^{-1} strain rate indicating more spread in the values achieved. The Comp-B stress at failure and modulus values at 10.0 s^{-1} showed increases when comparing the values achieved at 0.1 and 1.0 s^{-1} strain rates.

At 100.0 s^{-1} strain rate, both lots showed significant increases in the stress at failure and modulus values. This was likely due to the increased strain rate and suggested that the TNT and

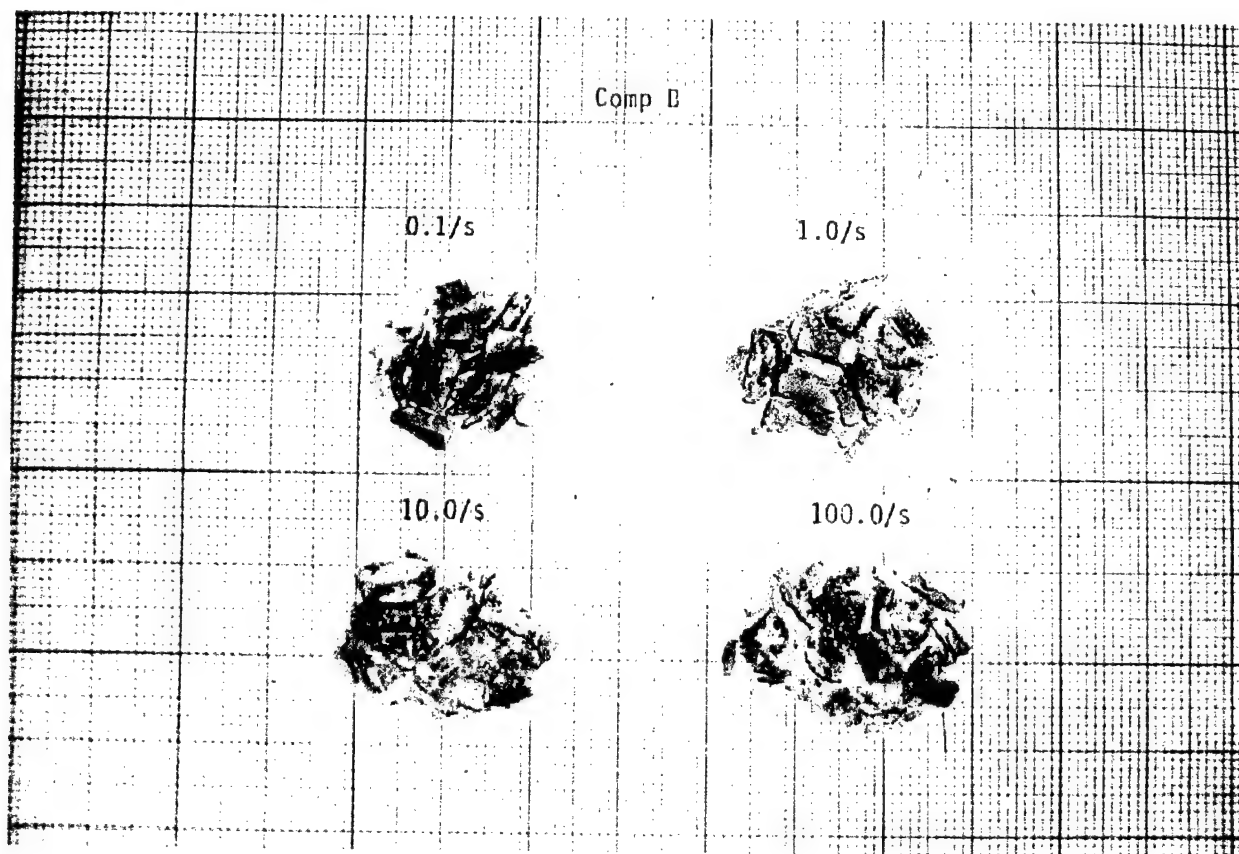


Figure 4. Photograph of Tested Comp-B Materials.

Comp-B lots were somewhat sensitive to the increased strain rate. Significant increases were also noted in the standard deviation values at 100.0 s^{-1} strain rate.

The fracture assessment values (FAV) indicated the amount of physical damage visually observed in the tested materials (Figures 2 and 3). It was noted that the FAVs were similar at all four strain rates. This was likely due to secondary loading after initial failure as the specimens were subjected to 80% end strain. Additional testing at ~10% end strain with closed bomb burning is recommended to determine more accurate fracture assessment and surface area evaluation.

The appendix contains several lots of quasi-similar materials that were tested in uniaxial compression at $21 \text{ }^{\circ}\text{C}$ using strain rates of 100.0 s^{-1} . The values may be used for comparing the TNT and Comp-B values achieved at 100.0 s^{-1} strain rate.

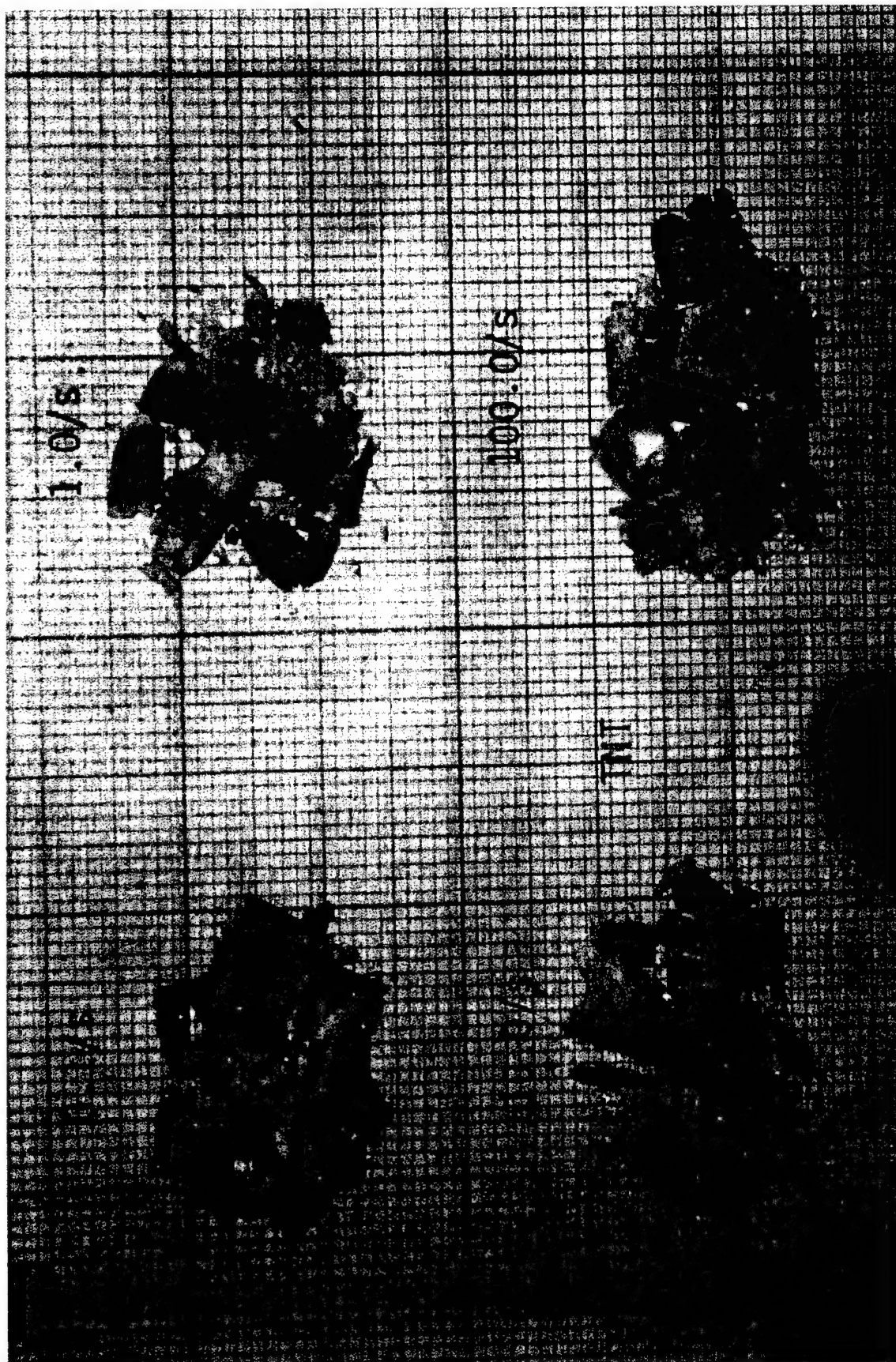


Figure 5. Photograph of Tested TNT Materials.

INTENTIONALLY LEFT BLANK.

4. References

1. Gazonas, G. A. "The Mechanical Response of M30, XM39, and JA2 Propellants at Strain Rates from 10^{-2} to 250 Sec^{-1} ." BRL-TR-3181, U.S. Army Ballistics Research Laboratory, Aberdeen Proving Ground, MD, January 1991.
2. Lieb, R. J. "Impact-Generated Surface Area in Gun Propellant." BRL-TR-2946, U.S. Army Ballistics Research Laboratory, Aberdeen Proving Ground, MD, November 1988.
3. Lieb, R. J., and J. J. Rocchio. "High Strain Rate Mechanical Properties Testing on Lots of Solid Gun Propellant With Deviant Interior Ballistic Performance." *1982 JANNAF Structures and Mechanical Behavior Subcommittee Meeting*, Aberdeen Proving Ground, MD, pp. 23-38, 1982.
4. Leadore, M. G. "MTS Servo-Hydraulic Tester (SHT) Mechanical Properties Evaluation of M43 Propellants." ARL-TN-5, U.S. Army Research Laboratory, Aberdeen Proving Ground, MD, March 1993.
5. Leadore, M. G., and C. J. Gillich. "Material Testing System (MTS) Servo-Hydraulic Tester (SHT) Mechanical Response of Energetic Thermal Plastic Elastomer (ETPE) RDX Based Propellants." ARL-TN-28, U.S. Army Research Laboratory, Aberdeen Proving Ground, MD, April 1994.
6. Lieb, R. J. Personal communication. U.S. Army Research Laboratory, Aberdeen Proving Ground, MD, October 1999.
7. Leadore, M. G. "Mechanical Response of JAG, RPD351, and RPD351MOD High-Energy Gun Propellant." ARL-TN-56, U.S. Army Research Laboratory, Aberdeen Proving Ground, MD, August 1995.
8. Lieb, R. J., and M. G. Leadore. "Mechanical Response Comparison of Gun Propellants Evaluated Under Equivalent Time-Temperature Conditions." ARL-TR-228, U.S. Army Research Laboratory, Aberdeen Proving Ground, MD, September 1993.
9. Leadore, M. G. "High-Strain Rate Mechanical Response of Composition Explosive AX Classic with 2:1, 3:1, and 4:1 Plasticizer-to-Binder Ratio." ARL-MR-365, U.S. Army Research Laboratory, Aberdeen Proving Ground, MD, September 1997.

INTENTIONALLY LEFT BLANK.

Appendix:

Quasi-Similar Materials
Tested in Uniaxial Compression
at 21 °C Using Strain Rates of 100.0 s⁻¹

INTENTIONALLY LEFT BLANK.

Table A-1. Mechanical Response of Detasheet and AX Classic HE at Strain Rates of 100.0 s^{-1}

Lot Number at 21 °C	Maximum Stress (MPa) (±)	At Strain (%) (±)	Modulus (GPa) (±)	FMOD (GPa) (±)	IED (MPa) (±)	FAV
100.0 s^{-1} Detasheet C-6 SN137500A013496	98.91 5.65	69.04 3.05	0.0515 0.001	0.315 0.002	2.06 0.013	7B
100.0 s^{-1} AX Classic 4X26SE96G1-001 1/4 RDX/PETN	12.75 0.91	64.34 3.55	0.0095 0.004	-0.098 0.002	0.550 0.035	0

Table A-2. Mechanical Response of JA2 Gun Propellant at Strain Rates of 100.0 s^{-1}

Lot Number at 21 °C	Stress at Failure (MPa) (±)	Strain at Failure (%) (±)	Modulus (GPa) (±)	Failure Modulus (GPa) (±)	IED (MPa) (±)	FAV
100.0 s^{-1} RAD-PE-472-123 JA2 Granular	22.23 1.78	3.52 0.32	0.673 0.088	0.030 0.002	4.94 0.34	3B
100.0 s^{-1} RAD-PDI-002-1F JA2 Stick	23.58 0.55	4.55 0.17	0.574 0.031	0.049 0.005	5.28 0.13	2B

INTENTIONALLY LEFT BLANK.

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
2	DEFENSE TECHNICAL INFORMATION CENTER DTIC DDA 8725 JOHN J KINGMAN RD STE 0944 FT BELVOIR VA 22060-6218
1	HQDA DAMO FDT 400 ARMY PENTAGON WASHINGTON DC 20310-0460
1	OSD OUSD(A&T)/ODDDR&E(R) R J TREW THE PENTAGON WASHINGTON DC 20301-7100
1	DPTY CG FOR RDA US ARMY MATERIEL CMD AMCRDA 5001 EISENHOWER AVE ALEXANDRIA VA 22333-0001
1	INST FOR ADVNCD TCHNLGY THE UNIV OF TEXAS AT AUSTIN PO BOX 202797 AUSTIN TX 78720-2797
1	DARPA B KASPAR 3701 N FAIRFAX DR ARLINGTON VA 22203-1714
1	NAVAL SURFACE WARFARE CTR CODE B07 J PENNELLA 17320 DAHLGREN RD BLDG 1470 RM 1101 DAHLGREN VA 22448-5100
1	US MILITARY ACADEMY MATH SCI CTR OF EXCELLENCE MADN MATH MAJ HUBER THAYER HALL WEST POINT NY 10996-1786

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
1	DIRECTOR US ARMY RESEARCH LAB AMSRL D D R SMITH 2800 POWDER MILL RD ADELPHI MD 20783-1197
1	DIRECTOR US ARMY RESEARCH LAB AMSRL DD 2800 POWDER MILL RD ADELPHI MD 20783-1197
1	DIRECTOR US ARMY RESEARCH LAB AMSRL CI AI R (RECORDS MGMT) 2800 POWDER MILL RD ADELPHI MD 20783-1145
3	DIRECTOR US ARMY RESEARCH LAB AMSRL CI LL 2800 POWDER MILL RD ADELPHI MD 20783-1145
1	DIRECTOR US ARMY RESEARCH LAB AMSRL CI AP 2800 POWDER MILL RD ADELPHI MD 20783-1197
	<u>ABERDEEN PROVING GROUND</u>
4	DIR USARL AMSRL CI LP (BLDG 305)

<u>NO. OF</u> <u>COPIES</u>	<u>ORGANIZATION</u>	<u>NO. OF</u> <u>COPIES</u>	<u>ORGANIZATION</u>
1	DIRECTOR US ARMY RESEARCH LAB AMSRL CP CA D SNIDER 2800 POWDER MILL RD ADELPHI MD 20783-1145	1	COMMANDER US ARMY MATERIEL CMD AMXMI INT 5001 EISENHOWER AVE ALEXANDRIA VA 22333-0001
1	DIRECTOR US ARMY RESEARCH LAB AMSRL OP SD TA 2800 POWDER MILL ROAD ADELPHI MD 20783-1145	2	COMMANDER US ARMY ARDEC AMSTA AR AE WW E BAKER J PEARSON PICATINNY ARSENAL NJ 07806-5000
3	DIRECTOR US ARMY RESEARCH LAB AMSRL OP SD TL 2800 POWDER MILL ROAD ADELPHI MD 20783-1145	1	COMMANDER US ARMY ARDEC AMSTA AR TD C SPINELLI PICATINNY ARSENAL NJ 07806-5000
1	DIRECTOR US ARMY RESEARCH LAB AMSRL OP SD TP 2800 POWDER MILL ROAD ADELPHI MD 20783-1145	1	COMMANDER US ARMY ARDEC AMSTA AR FSE T GORA PICATINNY ARSENAL NJ
2	DIRECTOR US ARMY RESEARCH LAB AMSRL OP CI AD TECH PUB BR RECORDS MGMT ADMIN 2800 POWDER MILL ROAD ADELPHI MD 20783-1197	6	COMMANDER US ARMY ARDEC AMSTA AR CCH A W ANDREWS S MUSALLI R CARR M LUCIANO E LOGSDEN T LOUZEIRO PICATINNY ARSENAL NJ 07806-5000
1	HQDA DAMI FIT NOLAN BLDG WASHINGTON DC 20310-1025	4	COMMANDER US ARMY ARDEC AMSTA AR CC G PAYNE J GEHBAUER C BAULIEU H OPAT PICATINNY ARSENAL NJ 07806-5000
1	DIRECTOR DA OASARDA SARD SO 103 ARMY PENTAGON WASHINGTON DC 20310-0103		
1	DEPUTY ASST SCY FOR R&T SARD TT RM 3EA79 THE PENTAGON WASHINGTON DC 20301-7100		

NO. OF
COPIES ORGANIZATION

1 COMMANDER
US ARMY ARDEC
AMSTA AR CCH P
J LUTZ
PICATINNY ARSENAL NJ
07806-5000

1 COMMANDER
US ARMY ARDEC
AMSTA AR FSF T
C LIVECCHIA
PICATINNY ARSENAL NJ
07806-5000

1 COMMANDER
US ARMY ARDEC
AMSTA AR QAC T C
C PATEL
PICATINNY ARSENAL NJ
07806-5000

2 COMMANDER
US ARMY ARDEC
AMSTA AR M
D DEMELLA
F DIORIO
PICATINNY ARSENAL NJ
07806-5000

3 COMMANDER
US ARMY ARDEC
AMSTA AR FSA
A WARNASH
B MACHAK
M CHIEFA
PICATINNY ARSENAL NJ
07806-5000

2 COMMANDER
US ARMY ARDEC
AMSTA AR FSP G
M SCHIKSNIS
D CARLUCCI
PICATINNY ARSENAL NJ
07806-5000

NO. OF
COPIES ORGANIZATION

1 COMMANDER
US ARMY ARDEC
AMSTA AR FSP A
P KISATSKY
PICATINNY ARSENAL NJ
07806-5000

2 COMMANDER
US ARMY ARDEC
AMSTA AR CCH C
H CHANIN
S CHICO
PICATINNY ARSENAL NJ
07806-5000

9 COMMANDER
US ARMY ARDEC
AMSTA AR CCH B
P DONADIA
F DONLON
P VALENTI
C KNUTSON
G EUSTICE
S PATEL
G WAGNECZ
R SAYER
F CHANG
PICATINNY ARSENAL NJ
07806-5000

6 COMMANDER
US ARMY ARDEC
AMSTA AR CCL
F PUZYCKI
R MCHUGH
D CONWAY
E JAROSZEWSKI
R SCHLENNER
M CLUNE
PICATINNY ARSENAL NJ
07806-5000

1 COMMANDER
US ARMY ARDEC
AMSTA AR QAC T
D RIGOGLIOSO
PICATINNY ARSENAL NJ
07806-5000

<u>NO. OF</u> <u>COPIES</u>	<u>ORGANIZATION</u>	<u>NO. OF</u> <u>COPIES</u>	<u>ORGANIZATION</u>
1	COMMANDER US ARMY ARDEC AMSTA AR SRE D YEE PICATINNY ARSENAL NJ 07806-5000	2	PEO FIELD ARTILLERY SYSTEMS SFAE FAS PM H GOLDMAN T MCWILLIAMS PICATINNY ARSENAL NJ 07806-5000
1	COMMANDER US ARMY ARDEC AMSTA AR WET T SACHAR BLDG 172 PICATINNY ARSENAL NJ 07806-5000	6	PM SADARM SFAE GCSS SD COL B ELLIS M DEVINE R KOWALSKI W DEMASSI J PRITCHARD S HROWNAK PICATINNY ARSENAL NJ 07806-5000
1	COMMANDER US ARMY ARDEC SMCAR ASF PICATINNY ARSENAL NJ 07806-5000	1	COMMANDER US ARMY ARDEC PRODUCTION BASE MODERN ACTY AMSMC PBM K PICATINNY ARSENAL NJ 07806-5000
1	COMMANDER US ARMY ARDEC AMSTA AR WEL F INTELLIGENCE SPECIALIST M GUERRIERE PICATINNY ARSENAL NJ 07806-5000	3	COMMANDER US ARMY TACOM PM TACTICAL VEHICLES SFAE TVL SFAE TVM SFAE TVH 6501 ELEVEN MILE RD WARREN MI 48397-5000
11	PROJECT MANAGER US ARMY TMAS SFAE GSSC TMA R MORRIS C KIMKER D GUZOWICZ E KOPACZ R ROESER R DARCY R MCDANOLDS L D ULISSE C ROLLER J MCGREEN B PATTTER PICATINNY ARSENAL NJ 07806-5000	1	COMMANDER US ARMY TACOM PM ABRAMS SFAE ASM AB 6501 ELEVEN MILE RD WARREN MI 48397-5000
		1	COMMANDER US ARMY TACOM PM BFVS SFAE ASM BV 6501 ELEVEN MILE RD WARREN MI 48397-5000

NO. OF
COPIES ORGANIZATION

1 COMMANDER
US ARMY TACOM
PM AFAS
SFAE ASM AF
6501 ELEVEN MILE RD
WARREN MI 48397-5000

2 COMMANDER
US ARMY TACOM
PM SURV SYS
SFAE ASM SS
T DEAN
SFAE GCSS W GSI M
D COCHRAN
6501 ELEVEN MILE RD
WARREN MI 48397-5000

1 COMMANDER
US ARMY TACOM
PM RDT&E
SFAE GCSS W AB
J GODELL
6501 ELEVEN MILE RD
WARREN MI 48397-5000

1 COMMANDER
US ARMY TACOM
PM SURVIVABLE SYSTEMS
SFAE GCSS W GSI H
M RYZYI
6501 ELEVEN MILE RD
WARREN MI 48397-5000

1 COMMANDER
US ARMY TACOM
PM BFV
SFAE GCSS W BV
S DAVIS
6501 ELEVEN MILE RD
WARREN MI 48397-5000

1 COMMANDER
US ARMY TACOM
PM LIGHT TACTICAL
VEHICLES
AMSTA TR S
AJ J MILLS MS 209
6501 ELEVEN MILE RD
WARREN MI 48397-5000

NO. OF
COPIES ORGANIZATION

1 COMMANDER
US ARMY TACOM
PM GROUND SYSTEMS
INTEGRATION
SFAE GCSS W GSI
R LABATILLE
6501 ELEVEN MILE RD
WARREN MI 48397-5000

1 COMMANDER
US ARMY TACOM
CHIEF ABRAMS TESTING
SFAE GCSS W AB QT
T KRASKIEWICZ
6501 ELEVEN MILE RD
WARREN MI 48397-5000

1 COMMANDER
US ARMY TACOM
AMSTA SF
WARREN MI 48397-5000

1 COMMANDER
SMCWV QAE Q
B VANINA
BLDG 44
WATERVLIET ARSENAL
WATERVLIET NY 12189-4050

14 COMMANDER
US ARMY TACOM
ASMTA TR R
J CHAPIN
R MCCLELLAND
D THOMAS
J BENNETT
D HANSEN
AMSTA JSK
S GOODMAN
J FLORENCE
K IYER
J THOMSON
AMSTA TR D
D OSTBERG
L HINOJOSA
B RAJU
AMSTA CS SF
H HUTCHINSON
F SCHWARZ
WARREN MI 48397-5000

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
1	COMMANDER SMCWV SPM T MCCLOSKEY BLDG 253 WATERVLIET ARSENAL WATERVLIET NY 12189-4050
10	BENET LABS AMSTA AR CCB R FISCELLA G D ANDREA M SCAVULO G SPENCER P WHEELER K MINER J VASILAKIS G FRIAR R HASENBEIN SMCAR CCB R S SOPOK WATERVLIET NY 12189
2	TSM ABRAMS ATZK TS S JABURG W MEINSHAUSEN FT KNOX KY 40121
3	ARMOR SCHOOL ATZK TD R BAUEN J BERG A POMEY FT KNOX KY 40121
2	HQ IOC TANK AMMO TEAM AMSIO SMT R CRAWFORD W HARRIS ROCK ISLAND IL 61299-6000
1	DIRECTOR US ARMY AMCOM SFAE AV RAM TV D CALDWELL BUILDING 5300 REDSTONE ARSENAL AL 35898

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
4	DIRECTOR US ARMY CECOM NIGHT VISION & ELECTRONIC SENSORS DIRECTORATE AMSEL RD NV CM CCD R ADAMS R MCLEAN A YINGST AMSEL RD NV VISP E JACOBS 10221 BURBECK RD FT BELVOIR VA 22060-5806
2	CDR US ARMY AMCOM AVIATION APPLIED TECH DIR J SCHUCK FT EUSTIS VA 23604-5577
1	US ARMY CRREL P DUTTA 72 LYME RD HANOVER NH 03755
1	US ARMY CERL R LAMPO 2902 NEWMARK DR CHAMPAIGN IL 61822
2	US ARMY CORPS OF ENGINEERS CERD C T LIU CEW ET T TAN 20 MASS AVE NW WASHINGTON DC 20314
10	DIRECTOR US ARMY NATL GRND INTEL CTR D LEITER S EITELMAN M HOLTUS M WOLFE S MINGLEDORF H C ARDLEIGH J GASTON W GSTATTENBAUER R WARNER J CRIDER 220 SEVENTH STREET NE CHARLOTTESVILLE VA 22091

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
6	US ARMY SBCCOM SOLDIER SYSTEMS CTR BALLISTICS TEAM J WARD MARINE CORPS TEAM J MACKIEWICZ BUS AREA ADVOCACY TEAM W HASKELL SSCNC WST W NYKVIST T MERRILL S BEAUDOIN KANSAS ST NATICK MA 01760-5019
1	US ARMY COLD REGIONS RSCH & ENGRNG LAB P DUTTA 72 LYME RD HANOVER NH 03755
1	SYSTEM MANAGER ABRAMS ATZK TS LTC J H NUNN BLDG 1002 RM 110 FT KNOX KY 40121
9	US ARMY RESEARCH OFFICE A CROWSON J CHANDRA H EVERETT J PRATER R SINGLETON G ANDERSON D STEPP D KISEROW J CHANG PO BOX 12211 RESEARCH TRIANGLE PARK NC 27709-2211
1	DIRECTORATE OF CMBT DEVELOPMENT C KJORO 320 ENGINEER LOOP STE 141 FT LEONARD WOOD MO 65473-8929

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
1	COMMANDANT US ARMY FIELD ARTILLERY CTR ATFS CD LTC BUMGARNER FT SILL OK 73503 5600
1	CHIEF USAIC LTC T J CUMMINGS ATZB COM FT BENNING GA 31905-5800
1	NAVAL AIR SYSTEMS CMD J THOMPSON 48142 SHAW RD UNIT 5 PATUXENT RIVER MD 20670
1	NAVAL SURFACE WARFARE CTR DAHLGREN DIV CODE G06 DAHLGREN VA 22448
1	NAVAL SURFACE WARFARE CTR TECH LIBRARY CODE 323 17320 DAHLGREN RD DAHLGREN VA 22448
3	NAVAL RESEARCH LAB I WOLOCK CODE 6383 R BADALIANCE CODE 6304 L GAUSE WASHINGTON DC 20375
1	NAVAL SURFACE WARFARE CTR CRANE DIVISION M JOHNSON CODE 20H4 LOUISVILLE KY 40214-5245
2	COMMANDER NAVAL SURFACE WARFARE CTR CADEROCK DIVISION R PETERSON CODE 2020 M CRITCHFIELD CODE 1730 BETHESDA MD 20084
2	NAVAL SURFACE WARFARE CTR U SORATHIA C WILLIAMS CD 6551 9500 MACARTHUR BLVD WEST BETHESDA MD 20817

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>	<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
1	DAVID TAYLOR RESEARCH CTR SHIP STRUCTURES & PROTECTION DEPARTMENT CODE 1702 J CORRADO BETHESDA MD 20084	1	NAVSEA OJRI PEO DD21 PMS500 G CAMPONESCHI 2351 JEFFERSON DAVIS HWY ARLINGTON VA 22242-5165
2	DAVID TAYLOR RESEARCH CTR R ROCKWELL W PHYLLAIER BETHESDA MD 20054-5000	1	EXPEDITIONARY WARFARE DIV N85 F SHOUP 2000 NAVY PENTAGON WASHINGTON DC 20350-2000
1	OFFICE OF NAVAL RESEARCH D SIEGEL CODE 351 800 N QUINCY ST ARLINGTON VA 22217-5660	1	AFRL MLBC 2941 P STREET RM 136 WRIGHT PATTERSON AFB OH 45433-7750
8	NAVAL SURFACE WARFARE CTR J FRANCIS CODE G30 D WILSON CODE G32 R D COOPER CODE G32 J FRAYSSE CODE G33 E ROWE CODE G33 T DURAN CODE G33 L DE SIMONE CODE G33 R HUBBARD CODE G33 DAHLGREN VA 22448	1	AFRL MLSS R THOMSON 2179 12TH STREET RM 122 WRIGHT PATTERSON AFB OH 45433-7718
1	NAVAL SEA SYSTEMS CMD D LIESE 2531 JEFFERSON DAVIS HIGHWAY ARLINGTON VA 22242-5160	2	AFRL F ABRAMS J BROWN BLDG 653 2977 P STREET STE 6 WRIGHT PATTERSON AFB OH 45433-7739
1	NAVAL SURFACE WARFARE CTR M LACY CODE B02 17320 DAHLGREN RD DAHLGREN VA 22448	1	AFRL MLS OL L COULTER BLDG 100 BAY D 7278 4TH STREET HILL AFB UT 84056-5205
1	OFFICE OF NAVAL RESEARCH J KELLY 800 NORTH QUINCEY ST ARLINGTON VA 22217-5000	1	OSD JOINT CCD TEST FORCE OSD JCCD R WILLIAMS 3909 HALLS FERRY RD VICKSBURG MS 29180-6199
2	NAVAL SURFACE WARFARE CTR CARDEROCK DIVISION R CRANE CODE 2802 C WILLIAMS CODE 6553 3A LEGGETT CIR BETHESDA MD 20054-5000	1	DEFENSE NUCLEAR AGENCY INNOVATIVE CONCEPTS DIV R ROHR 6801 TELEGRAPH RD ALEXANDRIA VA 22310-3398

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
1	WATERWAYS EXPERIMENT D SCOTT 3909 HALLS FERRY RD SC C VICKSBURG MS 39180
3	DARPA M VANFOSEN S WAX L CHRISTODOULOU 3701 N FAIRFAX DR ARLINGTON VA 22203-1714
2	SERDP PROGRAM OFC PM P2 C PELLERIN B SMITH 901 N STUART ST SUITE 303 ARLINGTON VA 22203
1	FAA MIL HDBK 17 CHAIR L ILCEWICZ 1601 LIND AVE SW ANM 115N RESTON VA 98055
2	FAA TECH CTR D OPLINGER AAR 431 P SHYPRYKEVICH AAR 431 ATLANTIC CITY NJ 08405
1	OFC OF ENVIRONMENTAL MGMT US DEPT OF ENERGY P RITZCOVAN 19901 GERMANTOWN RD GERMANTOWN MD 20874-1928
1	LOS ALAMOS NATL LAB F ADDESSIO MS B216 PO BOX 1633 LOS ALAMOS NM 87545
1	OAK RIDGE NATL LAB R M DAVIS PO BOX 2008 OAK RIDGE TN 37831-6195

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
5	DIRECTOR LAWRENCE LIVERMORE NATL LAB R CHRISTENSEN S DETERESA F MAGNESS M FINGER MS 313 M MURPHY L 282 PO BOX 808 LIVERMORE CA 94550
7	NIST R PARNAS J DUNKERS M VANLANDINGHAM MS 8621 J CHIN MS 8621 D HUNSTON MS 8543 J MARTIN MS 8621 D DUTHINH MS 8611 100 BUREAU DR GAITHERSBURG MD 20899
1	OAK RIDGE NATL LAB C EBERLE MS 8048 PO BOX 2009 OAK RIDGE TN 37831
1	OAK RIDGE NATL LAB C D WARREN MS 8039 PO BOX 2009 OAK RIDGE TN 37922
3	DIRECTOR SANDIA NATL LABS ENG MECHANICS DEPT MS 9042 J HANDROCK YR KAN J LAUFFER PO BOX 969 LIVERMORE CA 94551-0969
1	LAWRENCE LIVERMORE NATIONAL LAB M MURPHY PO BOX 808 L 282 LIVERMORE CA 94550

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
3	NASA LANGLEY RESEARCH CTR MS 266 AMSRL VS W ELBER F BARTLETT JR G FARLEY HAMPTON VA 23681-0001
1	NASA LANGLEY RESEARCH CTR T GATES MS 188E HAMPTON VA 23661-3400
1	USDOT FEDERAL RAILROAD RDV 31 M FATEH WASHINGTON DC 20590
1	DOT FHWA J SCALZI 400 SEVENTH ST SW 3203 HNG 32 WASHINGTON DC 20590
1	FHWA E MUNLEY 6300 GEORGETOWN PIKE MCLEAN VA 22101
1	CENTRAL INTELLIGENCE AGENCY OTI WDAG GT W L WALTMAN PO BOX 1925 WASHINGTON DC 20505
1	MARINE CORPS INTEL ACTY D KOSITZKE 3300 RUSSELL RD SUITE 250 QUANTICO VA 22134-5011
1	NATL GRND INTELLIGENCE CTR DIRECTOR IANG TMT 220 SEVENTH ST NE CHARLOTTESVILLE VA 22902-5396
1	DIRECTOR DEFENSE INTELLIGENCE AGENCY TA 5 K CRELLING WASHINGTON DC 20310

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
1	GRAPHITE MASTERS INC J WILLIS 3815 MEDFORD ST LOS ANGELES CA 90063-1900
1	ADVANCED GLASS FIBER YARNS T COLLINS 281 SPRING RUN LN STE A DOWNINGTON PA 19335
1	COMPOSITE MATERIALS INC D SHORTT 19105 63 AVE NE PO BOX 25 ARLINGTON WA 98223
1	COMPOSITE MATERIALS INC R HOLLAND 11 JEWEL COURT ORINDA CA 94563
1	COMPOSITE MATERIALS INC C RILEY 14530 S ANSON AVE SANTA FE SPRINGS CA 90670
2	COMPOSIX D BLAKE L DIXON 120 O NEILL DR HEBRUN OHIO 43025
4	CYTEC FIBERITE R DUNNE D KOHLI M GILLIO R MAYHEW 1300 REVOLUTION ST HAVRE DE GRACE MD 21078
2	SIMULA J COLTMAN R HUYETT 10016 S 51ST ST PHOENIX AZ 85044
1	SIOUX MFG B KRIEL PO BOX 400 FT TOTTEN ND 58335

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
2	PROTECTION MATERIALS INC M MILLER F CRILLEY 14000 NW 58 CT MIAMI LAKES FL 33014
3	FOSTER MILLER J J GASSNER M ROYLANCE W ZUKAS 195 BEAR HILL RD WALTHAM MA 02354-1196
1	ROM DEVELOPMENT CORP R O MEARA 136 SWINEBURNE ROW BRICK MARKET PLACE NEWPORT RI 02840
2	TEXTRON SYSTEMS T FOLTZ M TREASURE 201 LOWELL ST WILMINGTON MA 08870-2941
1	JPS GLASS L CARTER PO BOX 260 SLATER RD SLATER SC 29683
1	O GARA HESS & EISENHARDT M GILLESPIE 9113 LESAINTE DR FAIRFIELD OH 45014
2	MILLIKEN RESEARCH CORP H KUHN M MACLEOD PO BOX 1926 SPARTANBURG SC 29303
1	CONNEAUGHT INDUSTRIES INC J SANTOS PO BOX 1425 COVENTRY RI 02816

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
1	BATTELLE C R HARGREAVES 505 KING AVE COLUMBUS OH 43201-2681
2	BATTELLE NATICK OPERATIONS J CONNORS B HALPIN 209 W CENTRAL ST STE 302 NATICK MA 01760
1	BATTELLE NW DOE PNNL T HALL MS K231 BATTELLE BLVD RICHLAND WA 99352
3	PACIFIC NORTHWEST LAB M SMITH G VAN ARSDALE R SHIPPELL PO BOX 999 RICHLAND WA 99352
1	ARMTEC DEFENSE PRODUCTS S DYER 85 901 AVE 53 PO BOX 848 COACHELLA CA 92236
2	ADVANCED COMPOSITE MATLS CORP P HOOD J RHODES 1525 S BUNCOMBE RD GREER SC 29651-9208
2	GLCC INC J RAY M BRADLEY 103 TRADE ZONE DR STE 26C WEST COLUMBIA SC 29170
2	AMOCO PERFORMANCE PRODUCTS M MICHNO JR J BANISAUUKAS 4500 MCGINNIS FERRY RD ALPHARETTA GA 30202-3944

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
1	SAIC M PALMER 2109 AIR PARK RD S E ALBUQUERQUE NM 87106
1	SAIC G CHRYSSOMALLIS 3800 W 80TH ST STE 1090 BLOOMINGTON MN 55431
1	AAI CORPORATION T G STASTNY PO BOX 126 HUNT VALLEY MD 21030-0126
1	JOHN HEBERT PO BOX 1072 HUNT VALLEY MD 21030-0126
12	ALLIANT TECHSYSTEMS INC C CANDLAND C AAKHUS R BECKER B SEE N VLAHAKUS R DOHRN S HAGLUND D FISHER W WORRELL R COPENHAFFER M HISSONG D KAMDAR 600 2ND ST NE HOPKINS MN 55343-8367
3	ALLIANT TECHSYSTEMS INC J CONDON E LYNAM J GERHARD WV01 16 STATE RT 956 PO BOX 210 ROCKET CENTER WV 26726-0210
1	APPLIED COMPOSITES W GRISCH 333 NORTH SIXTH ST ST CHARLES IL 60174

<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
1	PROJECTILE TECHNOLOGY INC 515 GILES ST HAVRE DE GRACE MD 21078
1	CUSTOM ANALYTICAL ENG SYS INC A ALEXANDER 13000 TENSOR LN NE FLINTSTONE MD 21530
2	LORAL VUGHT SYSTEMS G JACKSON K COOK 1701 W MARSHALL DR GRAND PRAIRIE TX 75051
5	AEROJET GEN CORP D PILLASCH T COULTER C FLYNN D RUBAREZUL M GREINER 1100 WEST HOLLYVALE ST AZUSA CA 91702-0296
3	HEXCEL INC R BOE F POLICELLI J POESCH PO BOX 98 MAGNA UT 84044
3	HERCULES INC G KUEBELER J VERMEYCHUK B MANDERVILLE JR HERCULES PLAZA WILMINGTON DE 19894
1	BRIGS COMPANY J BACKOFEN 2668 PETERBOROUGH ST HERNDON VA 22071-2443
1	ZERNOW TECHNICAL SERVICES L ZERNOW 425 W BONITA AVE STE 208 SAN DIMAS CA 91773

<u>NO. OF</u> <u>COPIES</u>	<u>ORGANIZATION</u>	<u>NO. OF</u> <u>COPIES</u>	<u>ORGANIZATION</u>
2	OLIN CORPORATION FLINCHBAUGH DIV E STEINER B STEWART PO BOX 127 RED LION PA 17356	1	BOEING R BOHLMANN PO BOX 516 MC 5021322 ST LOUIS MO 63166-0516
1	OLIN CORPORATION L WHITMORE 10101 9TH ST NORTH ST PETERSBURG FL 33702	2	BOEING DEFENSE & SPACE GRP W HAMMOND J RUSSELL S 4X55 PO BOX 3707 SEATTLE WA 98124-2207
1	DOW UT S TIDRICK 15 STERLING DR WALLINGFORD CT 06492	2	BOEING ROTORCRAFT P MINGURT P HANDEL 800 B PUTNAM BLVD WALLINGFORD PA 19086
5	SIKORSKY AIRCRAFT G JACARUSO T CARSTENSAN B KAY S GARBO M S S330A J ADELMANN 6900 MAIN ST PO BOX 9729 STRATFORD CT 06497-9729	1	BOEING DOUGLAS PRODUCTS DIV L J HART SMITH 3855 LAKEWOOD BLVD D800 0019 LONG BEACH CA 90846-0001
1	PRATT & WHITNEY D HAMBRICK 400 MAIN ST MS 114 37 EAST HARTFORD CT 06108	1	LOCKHEED MARTIN S REEVE 8650 COBB DR D 73 62 MZ 0648 MARIETTA GA 30063-0648
1	AEROSPACE CORP G HAWKINS M4 945 2350 E EL SEGUNDO BLVD EL SEGUNDO CA 90245	1	LOCKHEED MARTIN SKUNK WORKS D FORTNEY 1011 LOCKHEED WAY PALMDALE CA 93599-2502
2	CYTEC FIBERITE M LIN W WEB 1440 N KRAEMER BLVD ANAHEIM CA 92806	1	LOCKHEED MARTIN R FIELDS 1195 IRWIN CT WINTER SPRINGS FL 32708
1	HEXCEL T BITZER 11711 DUBLIN BLVD DUBLIN CA 94568	1	MATERIALS SCIENCES CORP B W ROSEN 500 OFFICE CENTER DR STE 250 FORT WASHINGTON PA 19034

NO. OF COPIES	ORGANIZATION
1	NORTHROP GRUMMAN CORP ELECTRONIC SENSORS & SYSTEMS DIV E SCHOCH MAILSTOP V 16 1745A WEST NURSERY RD LINTHICUM MD 21090
2	NORTHROP GRUMMAN ENVIRONMENTAL PROGRAMS R OSTERMAN A YEN 8900 E WASHINGTON BLVD PICO RIVERA CA 90660
1	UNITED DEFENSE LP D MARTIN PO BOX 359 SANTA CLARA CA 95052
1	UNITED DEFENSE LP G THOMAS PO BOX 58123 SANTA CLARA CA 95052
2	UNITED DEFENSE LP R BARRETT V HORVATICH MAIL DROP M53 328 W BROKAW RD SANTA CLARA CA 95052-0359
3	UNITED DEFENSE LP GROUND SYSTEMS DIVISION M PEDRAZZI MAIL DROP N09 A LEE MAIL DROP N11 M MACLEAN MAIL DROP N06 1205 COLEMAN AVE SANTA CLARA CA 95052
4	UNITED DEFENSE LP 4800 EAST RIVER RD R BRYNSVOLD P JANKE MS170 T GIOVANETTI MS236 B VAN WYK MS389 MINNEAPOLIS MN 55421-1498

NO. OF COPIES	ORGANIZATION
2	GENERAL DYNAMICS LAND SYSTEMS D REES M PASIK PO BOX 2074 WARREN MI 48090-2074
1	GENERAL DYNAMICS LAND SYSTEMS D BARTLE PO BOX 1901 WARREN MI 48090
1	GENERAL DYNAMICS LAND SYSTEMS MUSKEGON OPERATIONS W SOMMERS JR 76 GETTY ST MUSKEGON MI 49442
1	GENERAL DYNAMICS AMPHIBIOUS SYS SURVIVABILITY LEAD G WALKER 991 ANNAPOLIS WAY WOODBIDGE VA 22191
5	INST FOR ADVANCED TECH T KIEHNE H FAIR P SULLIVAN W REINECKE I MCNAB 4030 2 W BRAKER LN AUSTIN TX 78759
2	CIVIL ENGR RSCH FOUNDATION H BERNSTEIN PRESIDENT R BELLE 1015 15TH ST NW STE 600 WASHINGTON DC 20005
1	ARROW TECH ASSO 1233 SHELBURNE RD STE D 8 SOUTH BURLINGTON VT 05403-7700

NO. OF
COPIES ORGANIZATION

1 CONSULTANT
R EICHELBERGER
409 W CATHERINE ST
BEL AIR MD 21014-3613

1 UCLA MANE DEPT ENGR IV
H THOMAS HAHN
LOS ANGELES CA 90024-1597

2 UNIV OF DAYTON RESEARCH INST
RAN Y KIM
AJIT K ROY
300 COLLEGE PARK AVE
DAYTON OH 45469-0168

1 MIT
P LAGACE
77 MASS AVE
CAMBRIDGE MA 01887

1 IIT RESEARCH CTR
D ROSE
201 MILL ST
ROME NY 13440-6916

1 GEORGIA TECH RESEARCH INST
GEORGIA INST OF TECHNOLOGY
P FRIEDERICH
ATLANTA GA 30392

1 MICHIGAN ST UNIV
R AVERILL
3515 EB MSM DEPT
EAST LANSING MI 48824-1226

1 UNIV OF KENTUCKY
L PENN
763 ANDERSON HALL
LEXINGTON KY 40506-0046

1 UNIV OF WYOMING
D ADAMS
PO BOX 3295
LARAMIE WY 82071

NO. OF
COPIES ORGANIZATION

1 UNIV OF UTAH
DEPT OF MECH & INDUSTRIAL
ENGR
S SWANSON
SALT LAKE CITY UT 84112

2 PENNSYLVANIA STATE UNIV
R MCNITT
C BAKIS
227 HAMMOND BLDG
UNIVERSITY PARK PA 16802

1 PENNSYLVANIA STATE UNIV
RENATA S ENGEL
245 HAMMOND BLDG
UNIVERSITY PARK PA 16801

1 PURDUE UNIV
SCHOOL OF AERO & ASTRO
C T SUN
W LAFAYETTE IN 47907-1282

1 STANFORD UNIV
DEPARTMENT OF AERONAUTICS
AND AEROBALLISTICS
DURANT BUILDING
S TSAI
STANFORD CA 94305

1 UNIV OF DAYTON
J M WHITNEY
COLLEGE PARK AVE
DAYTON OH 45469-0240

7 UNIV OF DELAWARE
CTR FOR COMPOSITE MATRLS
J GILLESPIE
M SANTARE
G PALMESE
S YARLAGADDA
S ADVANI
D HEIDER
D KUKICH
201 SPENCER LABORATORY
NEWARK DE 19716

<u>NO. OF</u> <u>COPIES</u>	<u>ORGANIZATION</u>	<u>NO. OF</u> <u>COPIES</u>	<u>ORGANIZATION</u>
1	UNIV OF ILLINOIS AT URBANA CHAMPAIGN NATL CTR FOR COMPOSITE MATERIALS RESEARCH 216 TALBOT LABORATORY JECONOMY 104 S WRIGHT ST URBANA IL 61801		<u>ABERDEEN PROVING GROUND</u>
		1	COMMANDER US ARMY MATERIEL SYS ANALYSIS P DIETZ 392 HOPKINS RD AMXSY TD APG MD 21005-5071
3	THE UNIV OF TEXAS AT AUSTIN CTR FOR ELECTROMECHANICS J PRICE A WALLS J KITZMILLER 10100 BURNET RD AUSTIN TX 78758-4497	1	DIRECTOR US ARMY RESEARCH LAB AMSRL OP AP L APG MD 21005 5066
		115	DIR USARL AMSRL CI AMSRL CI H W STUREK AMSRL CI S A MARK AMSRL CS IO FI M ADAMSON AMSRL SL B J SMITH AMSRL SL BA AMSRL SL BL D BELY R HENRY AMSRL SL BG A YOUNG AMSRL SL I AMSRL WM B A HORST E SCHMIDT AMSRL WM BA W D AMICO F BRANDON AMSRL WM BC P PLOSTINS D LYON J NEWILL S WILKERSON A ZIELINSKI AMSRL WM BD B FORCH R FIFER R PESCE RODRIGUEZ B RICE
3	VA POLYTECHNICAL INST STATE UNIV DEPT OF ESM M W HYER K REIFSNIDER R JONES BLACKSBURG VA 24061-0219		
1	NORTH CAROLINA STATE UNIV CIVIL ENGINEERING DEPT W RASDORF PO BOX 7908 RALEIGH NC 27696-7908		
1	UNIV OF MARYLAND DEPT OF AEROSPACE ENGINEERING ANTHONY J VIZZINI COLLEGE PARK MD 20742		
1	DREXEL UNIV ALBERT S D WANG 32ND AND CHESTNUT STREETS PHILADELPHIA PA 19104		
1	SOUTHWEST RSCH INST ENGR & MATL SCIENCES DIV J RIEGEL 6220 CULEBRA RD PO DRAWER 28510 SAN ANTONIO TX 78228-0510		

NO. OF
COPIES ORGANIZATION

ABERDEEN PROVING GROUND (CONT)

AMSRL WM BE
G WREN
C LEVERITT
D KOOKER
AMSRL WM BR
C SHOEMAKER
J BORNSTEIN
AMSRL WM M
D VIECHNICKI
G HAGNAUER
J MCCAULEY
B TANNER
AMSRL WM MA
R SHUFORD
P TOUCHET
N BECK TAN
D FLANAGAN
L GHIORSE
D HARRIS
S MCKNIGHT
P MOY
S NGYUEN
P PATTERSON
G RODRIGUEZ
A TEETS
R YIN
AMSRL WM MB
B FINK
J BENDER
T BLANAS
T BOGETTI
R BOSSOLI
L BURTON
K BOYD
S CORNELISON
P DEHMER
R DOOLEY
W DRYSDALE
G GAZONAS
S GHIORSE
D GRANVILLE
D HOPKINS
C HOPPEL
D HENRY
R KASTE
M KLUSEWITZ
M LEADORE
R LIEB

NO. OF
COPIES ORGANIZATION

ABERDEEN PROVING GROUND (CONT)

AMSRL WM MB
E RIGAS
J SANDS
D SPAGNUOLO
W SPURGEON
J TZENG
E WETZEL
A ABRAHAMIAN
M BERMAN
A FRYDMAN
T LI
W MCINTOSH
E SZYMANSKI
AMRSL WM MC
J BEATTY
J SWAB
E CHIN
J MONTGOMERY
A WERESCZCAK
J LASALVIA
J WELLS
AMSRL WM MD
W ROY
S WALSH
AMSRL WM T
B BURNS
AMSRL WM TA
W GILlich
T HAVEL
J RUNYEON
M BURKINS
E HORWATH
B GOOCH
W BRUCHEY
AMSRL WM TC
R COATES
AMSRL WM TD
A DAS GUPTA
T HADUCH
T MOYNIHAN
F GREGORY
A RAJENDRAN
M RAFTENBERG
M BOTELER
T WEERASOORIYA
D DANDEKAR
A DIETRICH

NO. OF
COPIES ORGANIZATION

ABERDEEN PROVING GROUND (CONT)

AMSRL WM TE

A NILLER

J POWELL

AMSRL SS SD

H WALLACE

AMSRL SS SE R

R CHASE

AMSRL SS SE DS

R REYZER

R ATKINSON

AMSRL SE L

R WEINRAUB

J DESMOND

D WOODBURY

NO. OF
COPIES ORGANIZATION

1 R MARTIN
 MERL
 LTD
 TAMWORTH RD
 HERTFORD SG13 7DG
 UNITED KINGDOM

1 PW LAY
 SMC SCOTLAND
 DERA ROSYTH
 ROSYTH ROYAL DOCKYARD
 DUNFERMLINE FIFE KY 11 2XR
 UNITED KINGDOM

1 T GOTTESMAN
 CIVIL AVIATION ADMINISTRATION
 PO BOX 8
 BEN GURION INTERNL AIRPORT
 LOD 70150 ISRAEL

1 S ANDRE
 AEROSPATIALE
 A BTE CC RTE MD132
 316 ROUTE DE BAYONNE
 TOULOUSE 31060
 FRANCE

1 J BAUER
 DAIMLER BENZ AEROSPACE
 D 81663 MUNCHEN
 MUNICH
 GERMANY

3 DRA FORT HALSTEAD
 PETER N JONES
 DAVID SCOTT
 MIKE HINTON
 SEVEN OAKS KENT TN 147BP
 UNITED KINGDOM

1 FRANCOIS LESAGE
 DEFENSE RESEARCH ESTAB
 VALCARTIER
 PO BOX 8800
 COURCELETTE QUEBEC COA
 IRO CANADA

NO. OF
COPIES ORGANIZATION

2 ROYAL MILITARY COLLEGE OF
 SCIENCE SHRIVENHAM
 D BULMAN
 B LAWTON
 SWINDON WILTS SN6 8LA
 UNITED KINGDOM

1 SWISS FEDERAL ARMAMENTS
 WKS
 WALTER LANZ
 ALLMENDSTRASSE 86
 3602 THUN
 SWITZERLAND

1 PROFESSOR SOL BODNER
 ISRAEL INST OF
 TECHNOLOGY
 FACULTY OF MECHANICAL ENGR
 HAIFA 3200 ISRAEL

1 DSTO MATERIALS RSRCH LAB
 DR NORBERT BURMAN NAVAL
 PLATFORM VULNERABILITY SHIP
 STRUCTURES & MATERIALS DIV
 PO BOX 50
 ASCOT VALE VICTORIA
 AUSTRALIA 3032

1 PROFESSOR EDWARD CELENS
 ECOLE ROYAL MILITAIRE
 AVE DE LA RENAISSANCE 30
 1040 BRUXELLE
 BELGIQUE

1 DEF RES ESTABLISHMENT
 VALCARTIER
 ALAIN DUPUIS
 2459 BOULEVARD PIE XI NORTH
 VALCARTIER QUEBEC
 CANADA
 PO BOX 8800 COURCELETTE
 GOA IRO QUEBEC CANADA

NO. OF COPIES	ORGANIZATION
1	INSTITUT FRANCO ALLEMAND DE RECHERCHES DE SAINT LOUIS DE MARC GIRAUD RUE DU GENERAL CASSAGNOU BOITE POSTALE 34 F 68301 SAINT LOUIS CEDEX FRANCE
1	J MANSON ECOLE POLYTECH DMX LTC CH 1015 LAUSANNE SWITZERLAND
1	TNO PRINS MAURITS LAB ROB IJSSELSTEIN LANGE KLEIWEG 137 PO BOX 45 2280 AA RIJSWIJK THE NETHERLANDS
2	FOA NAT L DEFENSE RESEARCH ESTAB BO JANZON R HOLMLIN DIR DEPT OF WEAPONS & PROTECTION S 172 90 STOCKHOLM SWEDEN
2	DEFENSE TECH & PROC AGENCY GRND I CREWTHERR GENERAL HERZOG HAUS 3602 THUN SWITZERLAND
1	MINISTRY OF DEFENCE RAFAEL MEIR MAYSELESS ARMAMENT DEVELOPMENT AUTH PO BOX 2250 HAIFA 31021 ISRAEL
1	AKE PERSSON DYNAMEC RESEARCH AB PARADISGRND 7 S 151 36 SODERTALJE SWEDEN

NO. OF COPIES	ORGANIZATION
1	ERNST MACH INSTITUT EMI DIRECTOR HAUPTSTRASSE 18 79576 WEIL AM RHEIN GERMANY
1	ERNST MACH INSTITUT EMI ALOIS STILP ECKERSTRASSE 4 7800 FREIBURG GERMANY
1	IR HANS PASMAN TNO DEFENSE RESEARCH POSTBUS 6006 2600 JA DELFT THE NETHERLANDS
1	BITAN HIRSCH TACHKEMONY ST 6 NETAMUA 42611 ISRAEL
1	MANFRED HELD DEUTSCHE AEROSPACE AG DYNAMICS SYSTEMS PO BOX 1340 D 86523 SCHROBENHAUSEN GERMANY

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188
<small>Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project(0704-0188), Washington, DC 20503.</small>			
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE October 2000	3. REPORT TYPE AND DATES COVERED Final, Apr - Oct 99	
4. TITLE AND SUBTITLE Uniaxial Compression of TNT and Comp-B at Strain Rates of 0.1, 10.0, and 100.0 s ⁻¹		5. FUNDING NUMBERS 1L161102AH43	
6. AUTHOR(S) Michael G. Leadore and Frederick B. Pierce			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Research Laboratory ATTN: AMSRL-WM-MB Aberdeen Proving Ground, MD 21005-5069		8. PERFORMING ORGANIZATION REPORT NUMBER ARL-TR-2359	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES			
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.		12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) Two lots of TNT and Comp-B explosives were tested in uniaxial compression at strain rates of 0.1, 1.0, 10.0, and 100.0 s ⁻¹ . The materials were tested at 21 °C to an end strain of 80%. The stress at failure, strain at failure, compressive modulus, failure modulus, incremental energy density, and the fracture assessment values were recorded for each test.			
14. SUBJECT TERMS TNT, Comp-B, uniaxial compression, mechanical properties, fracture		15. NUMBER OF PAGES 38	
		16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UL

INTENTIONALLY LEFT BLANK.

USER EVALUATION SHEET/CHANGE OF ADDRESS

This Laboratory undertakes a continuing effort to improve the quality of the reports it publishes. Your comments/answers to the items/questions below will aid us in our efforts.

1. ARL Report Number/Author ARL-TR-2359 (Leadore) Date of Report October 2000

2. Date Report Received _____

3. Does this report satisfy a need? (Comment on purpose, related project, or other area of interest for which the report will be used.) _____

4. Specifically, how is the report being used? (Information source, design data, procedure, source of ideas, etc.) _____

5. Has the information in this report led to any quantitative savings as far as man-hours or dollars saved, operating costs avoided, or efficiencies achieved, etc? If so, please elaborate. _____

6. General Comments. What do you think should be changed to improve future reports? (Indicate changes to organization, technical content, format, etc.) _____

CURRENT
ADDRESS

Organization

Name

E-mail Name

Street or P.O. Box No.

City, State, Zip Code

7. If indicating a Change of Address or Address Correction, please provide the Current or Correct address above and the Old or Incorrect address below.

OLD
ADDRESS

Organization

Name

Street or P.O. Box No.

City, State, Zip Code

(Remove this sheet, fold as indicated, tape closed, and mail.)

(DO NOT STAPLE)